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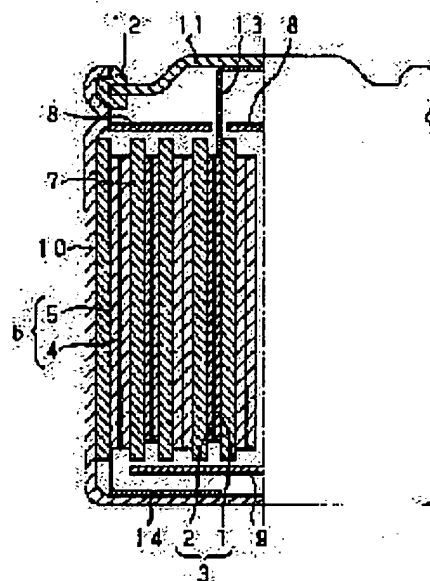
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(54) NONAQUEOUS ELECTROLYTE SECONDARY BATTERY

(57)Abstract:

PROBLEM TO BE SOLVED: To improve safety and reliability by making at least one of current collectors into a specified structure in a nonaqueous electrolyte secondary battery formed of a positive electrode and negative electrode having active materials held by current collectors, respectively, a separator, and a nonaqueous electrolyte.

SOLUTION: In a nonaqueous electrolyte secondary battery formed of a positive electrode 3 and negative electrode 6 having current collectors (a positive electrode current collector 1, a negative electrode current collector 4) held by active materials (a positive electrode active material 2, a negative electrode active material 5), a separator 7, and a nonaqueous electrolyte, at least one of the current collectors 1, 4 is formed of a plastic film (e.g. PP) having a metal thin film (e.g. Al thin film) formed thereon. Thus, when an internal short-circuit occurs, the internal short-circuit is quickly solved to recover the insulation, and the sudden temperature rise of the battery temperature by the internal short-circuit can be prevented.



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CLAIMS

[Claim(s)]

[Claim 1] The nonaqueous electrolyte rechargeable battery characterized by at least one side of the above-mentioned charge collector consisting of a plastic film which formed the metal thin film in the nonaqueous electrolyte rechargeable battery which consists of the positive electrode and negative electrode with which it comes to hold an active material at a charge collector, a separator, and nonaqueous electrolyte.

[Claim 2] The nonaqueous electrolyte rechargeable battery according to claim 1 characterized by for the active material of the above-mentioned positive electrode consisting of a metallic oxide which contains a lithium at least, and the active material of the above-mentioned negative electrode consisting a lithium of matter in which a dope and a dedope are possible.

[Claim 3] The nonaqueous electrolyte rechargeable battery according to claim 1 characterized by for the charge collector of the above-mentioned positive electrode consisting of a plastic film which formed the aluminum film, and the charge collector of the above-mentioned negative electrode consisting of copper foil.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Field of the Invention] Especially this invention relates to the lithium secondary battery used for the power source of the electronic equipment for portable etc. about a nonaqueous electrolyte rechargeable battery.

[0002]

[Description of the Prior Art] By remarkable advance of an electronic technique in recent years, miniaturization [of electronic equipment], lightweight-izing, and high performance-ization progresses, and the rechargeable battery with a high energy density is demanded of these electronic equipment. Although the nickel-cadmium battery, the lead cell, etc. were conventionally mentioned as a rechargeable battery used for these electronic equipment, it was inadequate in that a cell with a high energy density is obtained by these cells.

[0003] Under such a situation, lithium multiple oxides, such as a lithium cobalt multiple oxide, are used as a positive electrode, and research and development of the nonaqueous electrolyte rechargeable battery which used the matter in which a dope and a dedope of lithium ions, such as a carbon material, are possible as a negative electrode, and the so-called rechargeable lithium-ion battery are performed. It has a high energy consistency, and this rechargeable lithium-ion battery also has little self-discharge, and it excels in a cycle property and it has the outstanding property of being lightweight.

[0004] This rechargeable lithium-ion battery consists of a positive electrode which generally comes to apply positive active material to the positive-electrode charge collector which consists of aluminum foil, and a negative electrode which comes to apply a negative-electrode active material to the negative-electrode charge collector which consists of copper foil. And this rechargeable lithium-ion battery carries out the laminating of a negative electrode, a separator, a positive electrode, and the separator to this order, uses them as the laminating electrode object of four layer systems, and comes to contain the swirl type electrode object around which this laminating electrode object was wound many times with a cell can.

[0005]

[Problem(s) to be Solved by the Invention] However, when it charged more than 4.2V depending on the usage which the battery charger broke or was [user] mistaken, the lithium ion it became impossible to be able to finish going into a negative electrode deposited in the shape of a branch as a metal lithium, the internal short circuit occurred and the rechargeable lithium-ion battery which used the metallic foil for the charge collector had a possibility that it might become impossible for an internal short circuit to occur and use it by other reasons of any kind. Moreover, in this rechargeable lithium-ion battery, there was a possibility that an insulating condition might be maintained by this internal short circuit, and cell temperature might rise rapidly, and it was not desirable from the point of safety or dependability.

[0006] This invention is made in view of the above troubles, when an internal short circuit occurs, cancels an internal short circuit promptly, recovers an insulation, it prevents a temperature rise with the rapid cell temperature by the internal short circuit, and aims at offer of the nonaqueous electrolyte rechargeable battery which raised safety and dependability.

[0007]

[Means for Solving the Problem] As for the nonaqueous electrolyte rechargeable battery concerning this invention, an active material is characterized by consisting of a plastic film with which at least one side of the above-mentioned charge collector formed the metal thin film in the nonaqueous electrolyte rechargeable battery which consists of the positive electrode and negative electrode which it comes to hold at a charge collector, a separator, and nonaqueous electrolyte.

[0008] By having used for the charge collector the plastic film which formed the metal thin film, when an internal short circuit occurs, the nonaqueous electrolyte rechargeable battery concerning this invention constituted as mentioned above disperses a metal thin film in generation of heat by the short-circuit current which flows to the short circuit part, recovers an insulation, and it prevents a temperature rise with the rapid cell temperature by the internal short circuit.

[0009]

[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of the nonaqueous electrolyte rechargeable battery concerning this invention is explained to a detail, referring to a drawing.

[0010] A nonaqueous electrolyte rechargeable battery consists of a positive electrode 3 which applies positive active material 2 to the positive-electrode charge collector 1, and becomes it, and a negative electrode 6 which comes to apply the negative-electrode active material 5 to the negative-electrode charge collector 4, as shown in drawing 1. And this nonaqueous electrolyte rechargeable battery carries out the laminating of a positive electrode 3, a separator 7, a negative electrode 6, and the separator 7 to this order, and uses them as a laminating electrode object, and it comes to contain it with the cell can 10 in the condition of the swirl type electrode object on which it comes to wind this laminating electrode object many times of having arranged insulators 8 and 9 up and down.

[0011] the cell can 10 with which said swirl type electrode object was contained -- the cell lid 11 -- the insulating obturation gasket 12 -- minding -- by closing, it is attached and connects with a positive electrode 3 or a negative electrode 6 electrically through the positive-electrode lead 13 and the negative-electrode lead 14, respectively, and it is constituted so that it may function as the positive electrode or negative electrode of a cell.

[0012] As for the above-mentioned positive-electrode charge collector 1, both sides of a plastic film 15 come to form membranes the metal thin film 16. Therefore, the laminating of the negative-electrode charge collector 4, the negative-electrode active material 5, a separator 7, positive active material 2, the metal thin film 16, a plastic film 15, and the metal thin film 16 is carried out to this order, and the above-mentioned laminating electrode object is constituted, as shown in drawing 2.

[0013] By the way, as shown in drawing 3 (a), the internal short circuit direct continuation of the negative-electrode charge collector 4 is carried out [short circuit] to the metal thin film 16 by a certain reason may occur. When an internal short circuit occurs, as shown in drawing 3 (b), the metal thin film 16 formed by the plastic film 15 by generation of heat by the short-circuit current which flows to the short circuit part S is dispersed, consequently an insulating condition is recovered in the short circuit part S.

[0014] Therefore, by having the positive-electrode charge collector 1 which consists of a plastic film 15 with which the metal thin film 16 was formed, this nonaqueous electrolyte rechargeable battery recovers an insulating condition, also when an internal short circuit occurs, and it controls generating of the defective by the internal short circuit. Moreover, this nonaqueous electrolyte rechargeable battery prevents inconvenient points, such as rapid lifting of the cell temperature by the internal short circuit.

[0015] The plastic film 15 with which the metal thin film 16 was formed can be manufactured by the manufacture approach of the conventional known, for example, can carry out heating evaporation of the metal under a high vacuum, and the front face of the plastic film 15 which set the steam under the same high vacuum can be made to be able to condense it, and it can vapor-deposit the metal thin film 16.

[0016] Insulators, such as a macromolecule substrate formed with polymeric materials which are represented by a polypropylene film, the polyethylene film, etc., are used for the above-mentioned plastic film 15. Moreover, although especially the above-mentioned metal thin film 16 is not limited, as mentioned above, a current can be collected like aluminum and the thing in which low scattering of the melting point is comparatively possible is chosen.

[0017] In addition, as the above-mentioned positive active material 2, the active material containing Li_xMO_2 (however, M expresses one or more kinds of transition metals.) is usable. As this active material, multiple oxides, such as Li_xCoO_2 , Li_xNiO_2 , $\text{Li}_x\text{Mn}_2\text{O}_4$, Li_xMnO_3 , and $\text{Li}_x\text{Ni}_y\text{Co}(1-y)\text{O}_2$, are mentioned.

[0018] The above-mentioned multiple oxide uses the carbonate of a lithium, cobalt, and nickel as a start raw material, and is obtained by mixing according to a presentation and calcinating these carbonates under an oxygen existence ambient atmosphere in a 600 degrees C - 1000 degrees C temperature requirement. Moreover, a start raw material is not limited to a carbonate, but can be similarly compounded from a hydroxide and an oxide.

[0019] On the other hand as a negative-electrode active material 5, a lithium just possible [a dope and a dedope] Pyrolytic carbon and corks (pitch coke, needle coke, petroleum coke, etc.) graphite, glassy carbon, and an organic high-molecular-compound baking object (phenol resin --) Polymers, such as polyacethylene besides carbonaceous ingredients, such as what calcinated and carbonized furan resin etc. at suitable temperature, a carbon fiber, and activated carbon, or a metal lithium, and a lithium alloy (for example, lithium-aluminum containing alloy), and polypyrrole, are also usable.

[0020] Lithium salt is used as an electrolyte and the electrolytic solution made to dissolve this in an organic solvent is used for the electrolytic solution. Especially as an organic solvent, although not limited, the activity of independent or two or more kinds of mixed solvents, such as propylene carbonate, ethylene carbonate, 1, 2-dimethoxyethane, gamma-butyrolactone, a tetrahydrofuran, 2-methyl tetrahydrofuran, 1, 3-dioxolane, a sulfolane, an acetonitrile, diethyl carbonate, and dipropyl carbonate, is possible here, for example.

[0021] To an electrolyte, the activity of LiClO_4 , LiAsF_6 , LiPF_6 , LiBF_4 , $\text{LiB}(\text{C}_6\text{H}_5)_4$, LiCl , LiBr , $\text{CH}_3\text{SO}_3\text{Li}$, $\text{CF}_3\text{SO}_3\text{Li}$, etc. is possible.

[0022] Moreover, as for the nonaqueous electrolyte rechargeable battery concerning this invention, it is needless to say that you may have an insurance device with the relief valve which is not limited to the cell structure shown in drawing 1, and produces deformation with lifting of cell internal pressure, the PTC component which will intercept a current if cell temperature goes up.

[0023]

[Example] The example which produced the nonaqueous electrolyte rechargeable battery which consists of a configuration mentioned above hereafter is explained concretely.

[0024] an example 1 -- first, the positive electrode 3 was made like next and produced. Positive active material (LiCoO_2) 2 mixed a lithium carbonate and cobalt carbonate so that it might be set to $\text{Li}/\text{Co}(\text{mole ratio})=1$, and in air, 900 degrees C, they were calcinated for 5 hours and it obtained them.

[0025] Thus, graphite was mixed 6% of the weight as an electric conduction agent 91% of the weight, the obtained positive active material (LiCoO_2) 2 was mixed at a rate of 3 % of the weight of polyvinylidene fluorides as a binder, positive-electrode plied timber was produced, this was distributed to the N-methyl-2-pyrrolidone, and it considered as the shape of a slurry. Next, this slurry was applied to both sides of the band-like vacuum-plating-of-aluminium film which is the positive-

electrode charge collector 1, it pressed with the roller press machine after desiccation, and the positive electrode with a thickness of 160 micrometers was obtained. And width of face of 53.6mm and the die-length 523.5mm band-like positive electrode 3 were produced.

[0026] The positive-electrode charge collector 1 which consists of a vacuum-plating-of-aluminium film carried out heating evaporation of the aluminum under the high vacuum, and was obtained by forming the metal thin film 16 which the front face of the plastic film (polypropylene film) 15 which set the steam under the same high vacuum is made to condense, and consists of aluminum.

[0027] The negative electrode 6 was produced as follows. First, using a petroleum pitch as starting material, this was calcinated and coarse-grain-like pitch coke was obtained. This pitch coke was ground and it considered as powder with a mean particle diameter of 20 micrometers, and this powder was calcinated at 1000 degrees C among inert gas, the impurity was removed, and corks ingredient powder was obtained. Thus, the obtained negative-electrode active material 5 was mixed at a rate of 10 % of the weight of polyvinylidene fluorides as a binder 90% of the weight, negative-electrode plied timber was produced, this was distributed to the N-methyl-2-pyrrolidone, and it considered as the shape of a slurry. Next, this slurry was applied to both sides of the band-like copper foil which is the negative-electrode charge collector 4, compression formation was carried out with the roller press machine after desiccation, and the negative electrode with a thickness of 190 micrometers was obtained. And width of face of 53.6mm and the die-length 423.5mm band-like negative electrode 6 were produced.

[0028] It used with the band-like positive electrode 3 and negative electrode 6 which were produced as mentioned above, the laminating was carried out to a negative electrode 6, a separator 7, a positive electrode 3, a separator 7, and this order, and the laminating electrode object was acquired. And along the die-length direction, the negative electrode was ****ed inside, this laminating electrode object was wound around the eddy coil former many times, the last edge of the separator 7 of the outermost periphery was fixed on the tape, and the swirl type electrode object was produced.

[0029] Next, in the iron cell can 10 which performed nickel plating, the above-mentioned swirl type electrode object was contained, and insulators 8 and 9 have been arranged to vertical both sides of a swirl type electrode object. And the end of the positive-electrode lead 13 made from aluminum was welded to the positive-electrode charge collector 1 in order to take current collection of a positive electrode 3, and installation and the other end were welded to the cell lid 11. In addition, since the current tolerated dose of the metal thin film (vacuum-plating-of-aluminium film) 16 is small when a current is taken out with the direct positive-electrode lead 13, the positive-electrode charge collector 1 which consists of vacuum-plating-of-aluminium film sprayed the aluminum which dissolved in the end face of a swirl type electrode object in the shape of a fog, formed the contact innumerable, and has obtained the whole necessary current tolerated dose. Moreover, in order to take current collection of a negative electrode 1, the end of the negative-electrode lead 14 made from nickel was stuck to the negative-electrode charge collector 4 by pressure, and the other end was welded to the cell can 6.

[0030] 5.0g of electrolytic solutions which carried out 1 mol/l dissolution of LiPF₆ was poured in into the equivalent mixed solvent of propylene carbonate 50 capacity % and diethyl carbonate 50 capacity %, and the swirl type electrode object was made to carry out impregnation into this cell can 10. And the cell lid 11 was fixed by closing the cell can 10 through the insulating obturation gasket 12 which applied the front face with asphalt, and the cylindrical shape nonaqueous electrolyte rechargeable battery with a diameter [of 18mm] and a height of 65mm was produced.

[0031] The cylindrical nonaqueous electrolyte rechargeable battery was produced like the example 1 except having used aluminium foil for the charge collector 1 of example of comparison 1 positive electrode 3.

[0032] Thus, about the cell of the example 1 produced and the example 1 of a comparison, the internal short circuit was imitated and the peg test was performed. The result is shown in drawing 4.

[0033] Foolish ***** fell only and, as for the cell of an example 1, cell voltage is maintained after that so that drawing 4 may show. On the other hand, as for the cell of the example 1 of a comparison, cell voltage is continuing falling.

[0034] Moreover, rapid lifting of cell temperature was not seen under the severe condition on which internal short circuits, such as a overcharge condition, tend to generate the cell of an example 1.

[0035] From these results, when an internal short circuit occurs, the cell of the example 1 with the positive-electrode charge collector 1 which consists of a vacuum-plating-of-aluminium film disperses the aluminum film in generation of heat by the short-circuit current which flows to the short circuit part S, recovers an insulation, and maintains cell voltage. Moreover, since the cell of an example 1 can recover an insulation, it can prevent rapid lifting of cell temperature by the internal short circuit.

[0036]

[Effect of the Invention] When an internal short circuit occurs, the nonaqueous-electrolyte rechargeable battery built over this invention so that clearly from explanation as mentioned above can disperse a metal thin film in generation of heat by the short-circuit current which flows to the short circuit part, can recover an insulation, can prevent a temperature rise with the rapid cell temperature by the internal short circuit, and can raise safety and dependability by having used for the charge collector the plastic film which formed the metal thin film.

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TECHNICAL FIELD

[Field of the Invention] Especially this invention relates to the lithium secondary battery used for the power source of the electronic equipment for portable etc. about a nonaqueous electrolyte rechargeable battery.

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PRIOR ART

[Description of the Prior Art] By remarkable advance of an electronic technique in recent years, miniaturization [of electronic equipment], lightweight-izing, and high performance-ization progresses, and the rechargeable battery with a high energy density is demanded of these electronic equipment. Although the nickel-cadmium battery, the lead cell, etc. were conventionally mentioned as a rechargeable battery used for these electronic equipment, it was inadequate in that a cell with a high energy density is obtained by these cells.

[0003] Under such a situation, lithium multiple oxides, such as a lithium cobalt multiple oxide, are used as a positive electrode, and research and development of the nonaqueous electrolyte rechargeable battery which used the matter in which a dope and a dedope of lithium ions, such as a carbon material, are possible as a negative electrode, and the so-called rechargeable lithium-ion battery are performed. It has a high energy consistency, and this rechargeable lithium-ion battery also has little self-discharge, and it excels in a cycle property and it has the outstanding property of being lightweight.

[0004] This rechargeable lithium-ion battery consists of a positive electrode which generally comes to apply positive active material to the positive-electrode charge collector which consists of aluminum foil, and a negative electrode which comes to apply a negative-electrode active material to the negative-electrode charge collector which consists of copper foil. And this rechargeable lithium-ion battery carries out the laminating of a negative electrode, a separator, a positive electrode, and the separator to this order, uses them as the laminating electrode object of four layer systems, and comes to contain the swirl type electrode object around which this laminating electrode object was wound many times with a cell can.

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EFFECT OF THE INVENTION

[Effect of the Invention] When an internal short circuit occurs, the nonaqueous-electrolyte rechargeable battery built over this invention so that clearly from explanation as mentioned above can disperse a metal thin film in generation of heat by the short-circuit current which flows to the short circuit part, can recover an insulation, can prevent a temperature rise with the rapid cell temperature by the internal short circuit, and can raise safety and dependability by having used for the charge collector the plastic film which formed the metal thin film.

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TECHNICAL PROBLEM

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[0006] This invention is made in view of the above troubles, when an internal short circuit occurs, cancels an internal short circuit promptly, recovers an insulation, it prevents a temperature rise with the rapid cell temperature by the internal short circuit, and aims at offer of the nonaqueous electrolyte rechargeable battery which raised safety and dependability.

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MEANS

[Means for Solving the Problem] As for the nonaqueous electrolyte rechargeable battery concerning this invention, an active material is characterized by consisting of a plastic film with which at least one side of the above-mentioned charge collector formed the metal thin film in the nonaqueous electrolyte rechargeable battery which consists of the positive electrode and negative electrode which it comes to hold at a charge collector, a separator, and nonaqueous electrolyte.

[0008] By having used for the charge collector the plastic film which formed the metal thin film, when an internal short circuit occurs, the nonaqueous electrolyte rechargeable battery concerning this invention constituted as mentioned above disperses a metal thin film in generation of heat by the short-circuit current which flows to the short circuit part, recovers an insulation, and it prevents a temperature rise with the rapid cell temperature by the internal short circuit.

[0009]

[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of the nonaqueous electrolyte rechargeable battery concerning this invention is explained to a detail, referring to a drawing.

[0010] A nonaqueous electrolyte rechargeable battery consists of a positive electrode 3 which applies positive active material 2 to the positive-electrode charge collector 1, and becomes it, and a negative electrode 6 which comes to apply the negative-electrode active material 5 to the negative-electrode charge collector 4, as shown in drawing 1. And this nonaqueous electrolyte rechargeable battery carries out the laminating of a positive electrode 3, a separator 7, a negative electrode 6, and the separator 7 to this order, and uses them as a laminating electrode object, and it comes to contain it with the cell can 10 in the condition of the swirl type electrode object on which it comes to wind this laminating electrode object many times of having arranged insulators 8 and 9 up and down.

[0011] the cell can 10 with which said swirl type electrode object was contained -- the cell lid 11 -- the insulating obturation gasket 12 -- minding -- by closing, it is attached and connects with a positive electrode 3 or a negative electrode 6 electrically through the positive-electrode lead 13 and the negative-electrode lead 14, respectively, and it is constituted so that it may function as the positive electrode or negative electrode of a cell.

[0012] As for the above-mentioned positive-electrode charge collector 1, both sides of a plastic film 15 come to form membranes the metal thin film 16. Therefore, the laminating of the negative-electrode charge collector 4, the negative-electrode active material 5, a separator 7, positive active material 2, the metal thin film 16, a plastic film 15, and the metal thin film 16 is carried out to this order, and the above-mentioned laminating electrode object is constituted, as shown in drawing 2.

[0013] By the way, as shown in drawing 3 (a), the internal short circuit direct continuation of the negative-electrode charge collector 4 is carried out [short circuit] to the metal thin film 16 by a certain reason may occur. When an internal short circuit occurs, as shown in drawing 3 (b), the metal thin film 16 formed by the plastic film 15 by generation of heat by the short-circuit current which flows to the short circuit part S is dispersed, consequently an insulating condition is recovered in the

short circuit part S.

[0014] Therefore, by having the positive-electrode charge collector 1 which consists of a plastic film 15 with which the metal thin film 16 was formed, this nonaqueous electrolyte rechargeable battery recovers an insulating condition, also when an internal short circuit occurs, and it controls generating of the defective by the internal short circuit. Moreover, this nonaqueous electrolyte rechargeable battery prevents inconvenient points, such as rapid lifting of the cell temperature by the internal short circuit.

[0015] The plastic film 15 with which the metal thin film 16 was formed can be manufactured by the manufacture approach of the conventional known, for example, can carry out heating evaporation of the metal under a high vacuum, and the front face of the plastic film 15 which set the steam under the same high vacuum can be made to be able to condense it, and it can vapor-deposit the metal thin film 16.

[0016] Insulators, such as a macromolecule substrate formed with polymeric materials which are represented by a polypropylene film, the polyethylene film, etc., are used for the above-mentioned plastic film 15. Moreover, although especially the above-mentioned metal thin film 16 is not limited, as mentioned above, a current can be collected like aluminum and the thing in which low scattering of the melting point is comparatively possible is chosen.

[0017] In addition, as the above-mentioned positive active material 2, the active material containing Li_xMO_2 (however, M expresses one or more kinds of transition metals.) is usable. As this active material, multiple oxides, such as Li_xCoO_2 , Li_xNiO_2 , $\text{Li}_x\text{Mn}_2\text{O}_4$, Li_xMnO_3 , and $\text{Li}_x\text{Ni}_y\text{Co}_{(1-y)}\text{O}_2$, are mentioned.

[0018] The above-mentioned multiple oxide uses the carbonate of a lithium, cobalt, and nickel as a start raw material, and is obtained by mixing according to a presentation and calcinating these carbonates under an oxygen existence ambient atmosphere in a 600 degrees C - 1000 degrees C temperature requirement. Moreover, a start raw material is not limited to a carbonate, but can be similarly compounded from a hydroxide and an oxide.

[0019] On the other hand as a negative-electrode active material 5, a lithium just possible [a dope and a dedope] Pyrolytic carbon and corks (pitch coke, needle coke, petroleum coke, etc.) graphite, glassy carbon, and an organic high-molecular-compound baking object (phenol resin --) Polymers, such as polyacethylene besides carbonaceous ingredients, such as what calcinated and carbonized furan resin etc. at suitable temperature, a carbon fiber, and activated carbon, or a metal lithium, and a lithium alloy (for example, lithium-aluminum containing alloy), and polypyrrole, are also usable.

[0020] Lithium salt is used as an electrolyte and the electrolytic solution made to dissolve this in an organic solvent is used for the electrolytic solution. Especially as an organic solvent, although not limited, the activity of independent or two or more kinds of mixed solvents, such as propylene carbonate, ethylene carbonate, 1, 2-dimethoxyethane, gamma-butyrolactone, a tetrahydrofuran, 2-methyl tetrahydrofuran, 1, 3-dioxolane, a sulfolane, an acetonitrile, diethyl carbonate, and dipropyl carbonate, is possible here, for example.

[0021] To an electrolyte, the activity of LiClO_4 , LiAsF_6 , LiPF_6 , LiBF_4 , $\text{LiB}(\text{C}_6\text{H}_5)_4$, LiCl , LiBr , $\text{CH}_3\text{SO}_3\text{Li}$, $\text{CF}_3\text{SO}_3\text{Li}$, etc. is possible.

[0022] Moreover, as for the nonaqueous electrolyte rechargeable battery concerning this invention, it is needless to say that you may have an insurance device with the relief valve which is not limited to the cell structure shown in drawing 1, and produces deformation with lifting of cell internal pressure, the PTC component which will intercept a current if cell temperature goes up.

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EXAMPLE

[Example] The example which produced the nonaqueous electrolyte rechargeable battery which consists of a configuration mentioned above hereafter is explained concretely.

[0024] an example 1 -- first, the positive electrode 3 was made like next and produced. Positive active material (LiCoO₂) 2 mixed a lithium carbonate and cobalt carbonate so that it might be set to Li/Co(mole ratio) = 1, and in air, 900 degrees C, they were calcinated for 5 hours and it obtained them.

[0025] Thus, graphite was mixed 6% of the weight as an electric conduction agent 91% of the weight, the obtained positive active material (LiCoO₂) 2 was mixed at a rate of 3 % of the weight of polyvinylidene fluorides as a binder, positive-electrode plied timber was produced, this was distributed to the N-methyl-2-pyrrolidone, and it considered as the shape of a slurry. Next, this slurry was applied to both sides of the band-like vacuum-plating-of-aluminium film which is the positive-electrode charge collector 1, it pressed with the roller press machine after desiccation, and the positive electrode with a thickness of 160 micrometers was obtained. And width of face of 53.6mm and the die-length 523.5mm band-like positive electrode 3 were produced.

[0026] The positive-electrode charge collector 1 which consists of a vacuum-plating-of-aluminium film carried out heating evaporation of the aluminum under the high vacuum, and was obtained by forming the metal thin film 16 which the front face of the plastic film (polypropylene film) 15 which set the steam under the same high vacuum is made to condense, and consists of aluminum.

[0027] The negative electrode 6 was produced as follows. First, using a petroleum pitch as starting material, this was calcinated and coarse-grain-like pitch coke was obtained. This pitch coke was ground and it considered as powder with a mean particle diameter of 20 micrometers, and this powder was calcinated at 1000 degrees C among inert gas, the impurity was removed, and corks ingredient powder was obtained. Thus, the obtained negative-electrode active material 5 was mixed at a rate of 10 % of the weight of polyvinylidene fluorides as a binder 90% of the weight, negative-electrode plied timber was produced, this was distributed to the N-methyl-2-pyrrolidone, and it considered as the shape of a slurry. Next, this slurry was applied to both sides of the band-like copper foil which is the negative-electrode charge collector 4, compression formation was carried out with the roller press machine after desiccation, and the negative electrode with a thickness of 190 micrometers was obtained. And width of face of 53.6mm and the die-length 423.5mm band-like negative electrode 6 were produced.

[0028] It used with the band-like positive electrode 3 and negative electrode 6 which were produced as mentioned above, the laminating was carried out to a negative electrode 6, a separator 7, a positive electrode 3, a separator 7, and this order, and the laminating electrode object was acquired. And along the die-length direction, the negative electrode was ****ed inside, this laminating electrode object was wound around the eddy coil former many times, the last edge of the separator 7 of the outermost periphery was fixed on the tape, and the swirl type electrode object was produced.

[0029] Next, in the iron cell can 10 which performed nickel plating, the above-mentioned swirl type

electrode object was contained, and insulators 8 and 9 have been arranged to vertical both sides of a swirl type electrode object. And the end of the positive-electrode lead 13 made from aluminum was welded to the positive-electrode charge collector 1 in order to take current collection of a positive electrode 3, and installation and the other end were welded to the cell lid 11. In addition, since the current tolerated dose of the metal thin film (vacuum-plating-of-aluminium film) 16 is small when a current is taken out with the direct positive-electrode lead 13, the positive-electrode charge collector 1 which consists of vacuum-plating-of-aluminium film sprayed the aluminum which dissolved in the end face of a swirl type electrode object in the shape of a fog, formed the contact innumerable, and has obtained the whole necessary current tolerated dose. Moreover, in order to take current collection of a negative electrode 1, the end of the negative-electrode lead 14 made from nickel was stuck to the negative-electrode charge collector 4 by pressure, and the other end was welded to the cell can 6.

[0030] 5.0g of electrolytic solutions which carried out 1 mol/l dissolution of LiPF₆ was poured in into the equivalent mixed solvent of propylene carbonate 50 capacity % and diethyl carbonate 50 capacity %, and the swirl type electrode object was made to carry out impregnation into this cell can 10. And the cell lid 11 was fixed by closing the cell can 10 through the insulating obturation gasket 12 which applied the front face with asphalt, and the cylindrical shape nonaqueous electrolyte rechargeable battery with a diameter [of 18mm] and a height of 65mm was produced.

[0031] The cylindrical nonaqueous electrolyte rechargeable battery was produced like the example 1 except having used aluminium foil for the charge collector 1 of example of comparison 1 positive electrode 3.

[0032] Thus, about the cell of the example 1 produced and the example 1 of a comparison, the internal short circuit was imitated and the peg test was performed. The result is shown in drawing 4.

[0033] Foolish ***** fell only and, as for the cell of an example 1, cell voltage is maintained after that so that drawing 4 may show. On the other hand, as for the cell of the example 1 of a comparison, cell voltage is continuing falling.

[0034] Moreover, rapid lifting of cell temperature was not seen under the severe condition on which internal short circuits, such as a overcharge condition, tend to generate the cell of an example 1.

[0035] From these results, when an internal short circuit occurs, the cell of the example 1 with the positive-electrode charge collector 1 which consists of a vacuum-plating-of-aluminium film disperses the aluminum film in generation of heat by the short-circuit current which flows to the short circuit part S, recovers an insulation, and maintains cell voltage. Moreover, since the cell of an example 1 can recover an insulation, it can prevent rapid lifting of cell temperature by the internal short circuit.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is nonaqueous electrolyte rechargeable battery outline drawing of longitudinal section which applied this invention.

[Drawing 2] It is the important section sectional view of the laminating electrode object of this nonaqueous electrolyte rechargeable battery.

[Drawing 3] It is the important section sectional view of the laminating electrode object which the internal short circuit generated in this nonaqueous electrolyte rechargeable battery.

[Drawing 4] It is property drawing showing aging of the cell voltage at the time of performing a peg test.

[Description of Notations]

1 Positive-Electrode Charge Collector, 2 Positive Active Material, 3 Positive Electrode, 4 Negative-Electrode Charge Collector, 5 Negative-Electrode Active Material
6 Negative Electrode, 7 8 Separator, 9 Insulator, 10 Cell Can, 11 Cell Lid, 12 Insulating Obturation Gasket, 13 Positive-Electrode Lead, 14 Negative-Electrode Lead, 15 Plastic Film, 16 Metal Thin Film

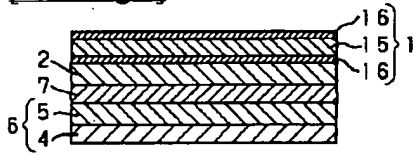
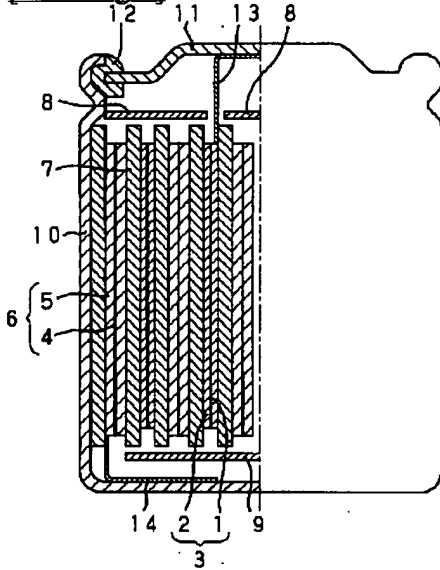
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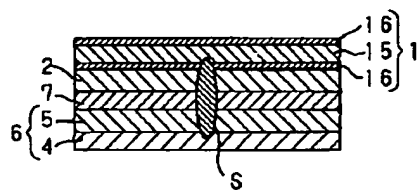
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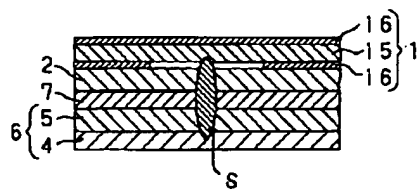
DRAWINGS

[Drawing 2]**[Drawing 1]****[Drawing 3]**

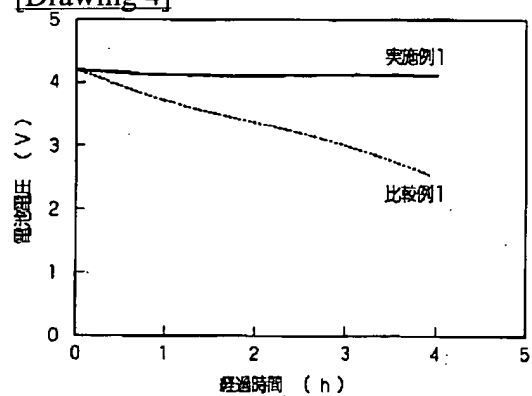
(a) ショート時



(b) 絶縁回復時



[Drawing 4]



[Translation done.]